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METHOD FOR ASSEMBLING LIQUID CRYSTAL SUBSTRATE, ITS ASSEMBLING DEVICE AND LIQUID CRYSTAL SUPPLYING DEVICE

[Abstract]

PROBLEM TO BE SOLVED: To produce a liquid crystal panel without irregularity of display.

SOLUTION: One of two substrates 1a, 1b as sticking objects is held on a lower surface of a pressurizing plate 27, the other substrate is held on a table 9, a supply route of a liquid crystal agent to be supplied on the other substrate is made into inactive gas atmosphere and the liquid crystal

agent is supplied there. And an interval of the respective faced substrates 1a, 1b is narrowed down and stuck together by an adhesive provided on either one of the respective substrates 1a, 1b.

[Claims]

[Claim 1]

An assembly method of a liquid crystal substrate, whereine of two sheets of substrates being target adhesion subjects is supported by the bottom of a pressurization plate, the other substrate is supported on a table, a liquid crystal agent is supplied to the other substrate, a distance between the opposite substrates is narrowed, and the substrates are adhered together using an adhesive provided on one of the substrates,

wherein the liquid crystal agent is supplied to the other substrate after the supply path of the supplied liquid crystal agent is made under an inert gas atmosphere.

[Claim 2]

An assembly method of a liquid crystal substrate, wherein one of two sheets of substrates being target adhesion subjects is supported by the bottom of a pressurization plate, the other substrate is supported on a table, a liquid crystal agent is supplied to the other substrate, a distance between the opposite substrates is narrowed, and the substrates are adhered together using an adhesive provided on one of the substrates,

wherein the liquid crystal agent is supplied to the other substrate after the supply path of the supplied liquid crystal agent is made under a vacuum atmosphere.

[Claim 3]

An assembly method of a liquid crystal substrate, wherein one of two sheets of substrates being target adhesion subjects is supported by the bottom of a pressurization plate, the other substrate is supported on a table, a liquid crystal agent is supplied to the other substrate, a distance between the opposite substrates is narrowed, and the substrates are adhered together using an adhesive provided on one of the substrates,

wherein when the liquid crystal agent is supplied to the other substrate, the supplied liquid crystal agent is sprayed.

[Claim 4]

The assembly method as claimed in claim 3, wherein the spraying of the liquid crystal agent is performed by spraying an inert gas from a two-fluid nozzle on the other substrate, and then sending the inert gas and the liquid crystal agent from the two-fluid nozzle.

[Claim 5]

The assembly method as claimed in claim 3 or 4, wherein after the liquid crystal agent is supplied, the inert gas is sprayed from the two-fluid nozzle to diffuse the liquid crystal agent on the other substrate in a diffusion direction of the principle surface of the other substrate.

[Claim 6]

An assembly apparatus of a liquid crystal substrate including a pressurization plate that supports one of two sheets of substrates being target adhesion subjects, a table that supports the other substrate and disposes the other substrate to the one of the substrates, and a liquid crystal supply device that supplies a liquid crystal agent on the other substrate,

wherein the liquid crystal supply device includes:

a liquid crystal supply unit that supplies the liquid crystal agent on the other substrate; and an inert gas supply unit that supplies an inert gas to the other substrate, thereby making an inert gas environment that surrounds the liquid crystal agent disposed adjacent to the liquid crystal supply unit.

[Claim 7]

A liquid crystal supply apparatus that supplies a liquid crystal agent on a liquid crystal substrate when fabricating the substrate, comprising:

a syringe that contains a liquid crystal agent to be supplied;

a liquid crystal supply unit that supplies the liquid crystal agent within the syringe on the substrate;

a cover that covers the circumference of the liquid crystal supply unit; and

an inert gas supply unit that supplies an inert gas into the cover.

[Claim 8]

A liquid crystal supply apparatus that supplies a liquid crystal agent on a liquid crystal substrate when fabricating the substrate, comprising:

a syringe that contains a liquid crystal agent;

a manifold communicating with the syringe;

a two-fluid nozzle communicating with the manifold; and

an inert gas supply unit that supplies an inert gas into the manifold.

[Title of the invention]

METHOD FOR ASSEMBLING LIQUID CRYSTAL SUBSTRATE, ITS ASSEMBLING DEVICE AND LIQUID CRYSTAL SUPPLYING DEVICE

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to a method of assembling a liquid crystal substrate and assembly apparatus thereof, and a liquid crystal supply apparatus, wherein substrates being a target adhesion subject with a liquid crystal agent therebetween are supported in an opposite manner, and a distance between the substrates is narrowed and adhered.

[0002]

[Description of the Prior Art]

In manufacturing a liquid crystal display panel, two sheets of glass substrates in which a transparent electrode or a thin film transistor array is disposed are adhered together with a very close distance of several μm (for example, 2μm) using a sealant having a □ shape, which is provided at the outer edge of the substrates or an adhesive coated on a proper location of the outer circumference of the substrate (the substrates after adhesion is referred to as "cell"). Each of the substrates and a space formed by the sealant or the adhesive is sealed using liquid crystal.

[0003]

Conventionally, a substrate adhesion method when performing sealing of liquid crystal includes Japanese Unexamined Patent Application Publication No. Sho62-89025 discloses a method in which liquid crystal is dropped on one of substrates in which the sealant is patterned in a close pattern (a □ shape) so that an inlet is not formed.

Further, the other substrate is disposed on one of the substrates within the vacuum chamber, a distance between the other substrate and one of the substrates is narrowed in the vacuum state, and the two substrates are pressurized and adhered together.

[0004]

[Means for Solving the Problem]

In the method disclosed in Japanese Unexamined Patent Application Publication No. Sho62-89025, however, moisture or impurities in the air are confined between the adhered substrates and the liquid crystal agent due to the inflow of the air when the liquid crystal agent is dropped. Thus, there is a problem in that the moisture or impurities remain on the substrates as dropped marks. There is also a problem in that a surface of the dropped liquid crystal agent is oxidized due to the moisture or impurities and thus remains as a dropped mark. Further, there is a problem in that a defect of a stain remains in an assembled liquid crystal panel because of the dropped mark.

[0005]

Accordingly, the present invention has been made in view of the above problems, and it is an object of the present invention to provide a method of assembling a liquid crystal substrate and assembly apparatus thereof, and a liquid crystal supply apparatus, wherein a liquid crystal panel with no a display stain can be produced by prohibiting generation of a dropped marks when dropping liquid crystal.

[0006]

[Means for Solving the Problem]

In order to accomplish the object, in the present invention according to Claim 1, there is provided a method of assembling a liquid crystal substrate, wherein on one of two sheets of substrates being target adhesion subjects is supported by the bottom of a pressurization plate, the other substrate is supported on a table, a liquid crystal agent is supplied to the other substrate, a distance between the opposite substrates is narrowed, and the substrates are adhered together using an adhesive provided on one of the substrates. In this case, the liquid crystal agent is supplied to the other substrate after the supply path of the supplied liquid crystal agent is made under an inert gas atmosphere.

[0007]

In the present invention according to Claim 2, there is provided a method of assembling a liquid crystal substrate, wherein one of two sheets of substrates being target adhesion subjects is supported by the bottom of a pressurization plate, the other substrate is supported on a table, a liquid crystal agent is supplied to the other substrate, a distance between the opposite substrates is narrowed, and the substrates are adhered together using an adhesive provided on one of the substrates. In this case, the liquid crystal agent is supplied to the other substrate after the supply path of the supplied liquid crystal agent is made under a vacuum atmosphere.

[0008]

In the present invention according to Claim 3, there is provided a method of assembling a liquid crystal substrate, wherein one of two sheets of substrates being target adhesion subjects is supported by the bottom of a pressurization plate, the other substrate is supported on a table, a liquid crystal agent is supplied to the other substrate, a distance between the opposite substrates is narrowed, and the substrates are adhered together using an adhesive provided on one of the substrates. At this time, when the liquid crystal agent is supplied to the other substrate, the supplied liquid crystal agent is sprayed.

[0009]

In the present invention according to Claim 4, in the method of assembling the liquid crystal substrate according to Claim 3, the spray of the liquid crystal agent is performed by spraying an inert gas from a two-fluid nozzle on the other substrate, and then sending the inert gas and the liquid crystal agent from the two-fluid nozzle.

[0010]

Furthermore, in the present invention according to Claim 5, in the method of assembling the liquid crystal substrate according to Claim 3 or 4, after the liquid crystal agent is supplied, the inert gas is sprayed from the two-fluid nozzle to diffuse the liquid crystal agent on the other substrate in a diffusion direction of the principle surface on the other substrate.

[0011]

In the present invention according to Claim 6, there is provided an assembly apparatus of a liquid crystal substrate including a pressurization plate that supports one of two sheets of substrates being target adhesion subjects, a table that supports the other substrate and disposes the other substrate to the one of the substrates, and a liquid crystal supply device that supplies a liquid crystal agent on the other substrate. In this case, the liquid crystal supply device includes a liquid crystal supply unit that supplies the liquid crystal agent on the other substrate, and an inert gas supply unit that supplies an inert gas to the other substrate, thereby making an inert gas environment that surrounds the liquid crystal agent disposed adjacent to the liquid crystal supply unit.

[0012]

In the present invention according to Claim 7, there is provided a liquid crystal supply apparatus that supplies a liquid crystal agent on a liquid crystal substrate when fabricating the substrate, including a syringe that contains a liquid crystal agent to be supplied, a liquid crystal supply unit that supplies the liquid crystal agent within the syringe on the substrate, a cover that covers the surroundings of the liquid crystal supply unit, and an inert gas supply unit that supplies an inert gas into the cover.

[0013]

In the present invention according to Claim 8, there is provided a liquid crystal supply apparatus that supplies a liquid crystal agent on a liquid crystal substrate when fabricating the substrate, including a syringe that contains a liquid crystal agent, a manifold communicating with the syringe, a two-fluid nozzle communicating with the manifold, and an inert gas supply unit that supplies an inert gas into the manifold.

[0014]

[Embodiment of the Invention]

An assembly apparatus of a liquid crystal substrate according to a first embodiment of the present invention will be described with reference to Figs. 1 to 3.

[0015]

The construction of the assembly apparatus of the liquid crystal substrate according to the present embodiment is shown in Fig. 1. The assembly apparatus of the liquid crystal substrate can mainly include a liquid crystal drop unit S1 being a liquid crystal supply apparatus, a substrate junction unit S2 which has a pressurization plate 27 that supports an upper substrate 1b and pressurizes the upper substrate 1b onto a lower substrate 1a, and a XYθ stage T1 having a table 9 that supports the lower substrate 1a thereon. In this case, the liquid crystal drop unit S1 and the substrate junction unit S2 are supported by a plurality of support poles that are erect on the mounting plate 2 and a frame 3 comprised of a horizontal member extending between the support poles, and are disposed adjacent to them. The XYθ stage T1 is disposed to move between the liquid crystal drop unit S1 and the substrate junction unit S2, and the mounting plate 2. The construction of each of them will be described.

[0016]

The liquid crystal drop unit S1 includes a dispenser 17 that drops a desired amount of a liquid crystal agent on the lower substrate 1a (the principle surface of the lower substrate 1a) located on the table 9 to be described later, a Z-axis stage 15 that supports the dispenser 17 and moves it in the up and down direction (the Z-axis direction in Fig. 1), and a motor 16 that supports the up- and down-motion of the Z-axis stage 15 in an elastic manner. The liquid crystal drop unit S1 constructed above maintains the Z-axis stage 15 using a bracket 14 that is projected from the frame 3 to be described later, which supports the substrate junction unit S2.

[0017]

In this case, the dispenser 17 will be described with reference to Fig. 3. The dispenser 17 includes a cover 17kthat covers the circumference of the drop unit, and a pipe (horse) 17h that introduces an inert gas such as nitrogen or argon gas into the cover 17k. At this time, to the dispenser 17 are coupled a pressure source (not shown) (for example, a pump) and an air filter. The inert gas that is sent from the pressure source passes through the air filter. The inert gas not containing impurities such as waste can be thus transferred. The flux of the transferred inert gas is controlled by the flow controller 17m. The transferred inert gas is supplied into the cover 17k through an electronic valve 17n, which operates according to a signal from the controller 17i, to the pipe 17h.

[0018]

Meanwhile, the syringe 17e contains a liquid crystal agent. At this time, in order to apply the pressure for drop to the liquid crystal agent, the transferred inert gas is pressurized and controlled in the pressure controller 17b, and is then send to the syringe 17e wit predetermined pressure power. The drop of the liquid crystal agent is executed in a plunger node (for example, Acuazeta S series by Nodeson Co. Ltd.). To be more precise, only when the electronic valve 17d that operates according to a signal form the controller 17i, a needle (not shown) within the syringe 17e is opened, and the inert gas is sent to the syringe 17e at the same time. Thus, an exact amount of the load of the liquid crystal agent is performed.

[0019]

At this time, though not shown in Fig. 1, a dispenser for discharging a sealant is disposed near the dispenser 17 for dropping the liquid crystal agent. The dispenser for discharging the sealant is fixed to the frame 3 through a bracket (not shown) in the same manner as the dispenser 17 for dropping the liquid crystal agent.

[0020]

The substrate junction unit S2 includes an upper chamber unit 21 whose bottom consisting of a decompression chamber and the lower chamber unit 10 to be described later is perforated, and a pressurization plate 27 that is disposed within the upper chamber unit 21 through a shafts 29 and has a suction adsorption device and an electrostatic adsorption device. The upper chamber unit 21 and the pressurization plate 27 move up and down independently.

[0021]

In particular, a through hole (not shown) through which a plurality of the shafts 29 penetrate is formed in the upper chamber unit 21. Further, on the top of the upper chamber unit 21 is formed a housing 30, which covers a gas between the through hole and the shafts 29 and has a linear bush and a vacuum seal covering the shafts 29 built in, and a cylinder 22, which fixes the body to the horizontal member of the frame 3 and fixes a member that reciprocally moves within the body in the up and down direction to the top of the upper chamber unit 21. Through this construction, the upper chamber unit 21 is moved in the up and down direction by means of the cylinder 22 using the shafts 29 as a guide.

[0022]

The vacuum seal of the above-described housing 30 is build so that vacuum leakage is not generated from a gap between the through hole and the shafts 29, although the upper chamber unit 21 and the lower chamber unit 10 are combined to form the decompression chamber and the housing 30 is thus deformed. For this reason, although load is applied to the shafts 29 due to the deformation of the decompression chamber, the vacuum seal can absorb the power.

Further, the vacuum seal can also prevent deformation of the pressurization plate 27 fixed to one end of the shafts 29. Thus, upon adhesion of the substrates 1a and 1b as described above, the adhesion can be performed with the upper substrate 1b fixed to the pressurization plate 27 and the lower substrate 1a fixed to the table 9 become parallel to each other.

[0023]

In this case, a flange 21a for performing air-tightening the decompression chamber when the decompression chamber is formed together with the lower chamber unit 10 is disposed at the bottom (the circumference of the aperture) of the upper chamber unit 21.

[0024]

Further, on the side of one side of the upper chamber unit 21 are disposed a pipe horse 24 that communicates with the decompression chamber in order to decompress the decompression chamber, a vacuum valve 23 disposed in the middle of the pipe horse 24, and the vacuum pump (not shown) coupled to the pipe horse 24.

[0025]

Furthermore, on the side of the other side of the upper chamber unit 21 are disposed a gas purge valve 25 that communicates with the decompression chamber in order to return the inside of the decompressed decompression chamber to an atmospheric pressure, a gas tube 26 couple to one end of the gas purge valve 25, and a pressurization pump that is coupled to the other end of the gas tube 26 and transmits nitrogen, clean dry air, etc.

[0026]

In this case, on the upper chamber unit 21 is disposed a plurality of windows for monitoring positional matching marks of the substrates 1a and 1b through marks recognition holes (not shown) that are formed in the pressurization plate 27. At this time, an image recognition camera (not shown) disposed at an upper side of the windows of the upper chamber unit 21 is used to monitor the positional matching marks. Deviation of the positional matching marks of the substrates 1a and 1b is measured by means of the image recognition camera.

[0027]

Thereafter, the pressurization plate 27 is fixed to one end of the shaft 29, as described above. In this case, the other end of the shaft 29 is fixed to the housing 31. The pressurization plate 27 is adapted to move up and down by means of the linear guide 34 disposed at both ends of the housing 31 and a guide member 3a disposed in the frame 3 that engages the linear guide 34. To be more precise, the pressurization plate 27 includes a housing 32 disposed on the housing 31, a load meter 33 disposed on a surface of the housing 32, a nut housing 37 which has an arm screw unit concaved in a spiral shape in the up and down direction and is disposed on the load meter 33, a ball screw 36 that is rotatably coupled to the arm screw unit of the nut housing 37, and a motor 40 which has an output axis and rotates a ball screw 36 around the axis. The motor 40 is driven to implement the up- and down-motion of the pressurization plate 27. At this time, the motor 40 is fixed to the bracket 38 on the frame 35 disposed on the frame 3.

[0028]

Through this construction, the motor 40 is driven to lower the pressurization plate 27 that supports the upper substrate 1b and to adhere the substrate 1b the lower substrate 1a on the table 9l, thus providing pressurization necessary for adhesion. In this case, the above-described load meter 33 operate as a pressurization sensor, and controls the motor 40 according to a feedback signal, thus providing desired pressurization to the substrates 1a and 1b.

[0029]

As described above, the pressurization plate 27 that moves up and down is provided with the suction adsorption device and the electrostatic adsorption device, as described above. The suction adsorption device includes a plurality of suction holes (not shown) formed from the bottom of the pressurization plate 27, a joint 41 for suction adsorption, which communicates with each of the suction hole and is disposed in the upper chamber unit 21, a suction tube 42 that communicates with the joint 41 for suction adsorption, and the vacuum pump (not shown) that is coupled to the suction tube 42. The suction adsorption device constructed above drives the vacuum pump under the atmosphere to adhere the upper substrate 1b to the bottom of the pressurization plate 27 by way of vacuum adsorption (or suction adsorption).

[0030]

Hereinafter, the electrostatic adsorption device will be described. The electrostatic adsorption device includes an almost square flat panel electrode in the present embodiment, and is mounted in each of two almost square concave portions formed at both ends of the bottom of the pressurization plate 27. Further, the flat panel electrode has its surface (a lower side of the pressurization plate 27) covered with dielectric substance. The principle surface of the dielectric substance confronts the bottom of the pressurization plate 27. As such, the flat panel electrode disposed in the pressurization plate 27 is coupled to positive or negative DC power through a proper switch. For this reason, if the positive or negative voltage is applied to each of the flat panel electrodes, negative or positive charges are caused in the principle surface of the dielectric substance. Further, the upper substrate 1b is electro-statically adsorbed to the pressurization plate 27 due to crone power generating between transparent electrode films formed in the upper substrate 1b. In this case, the voltages applied to the electrostatic adsorption electrodes can have the same polarity or a different polarity.

[0031]

Furthermore, in the case of the atmosphere, suction adsorption can be preferably performed using the aforementioned suction hole. This is because if electrostatic adsorption is performed, a discharge phenomenon is generated due to static electricity, damaging the upper substrate 1b or the pressurization plate 27 when an air layer exists between the upper substrate 1b and the pressurization plate 27. For this reason, for example, since the circumstance is under the atmosphere when the upper substrate 1b is first adhered to the pressurization plate 27, it is preferred suction adsorption is first performed by the suction adsorption device, and electrostatic adsorption is then performed after a decompression chamber is decompressed to the degree where the discharge phenomenon is not generated while the decompression room is decompressed.

[0032]

In this case, as will be described later, if the decompression chamber is decompressed in a state where the upper substrate 1b undergoes suction adsorption in the pressurization plate 27, there is a possibility that adsorption force thereof becomes weak and the upper substrate 1b may drop. Due to this, a container ring 60 for containing the upper substrate 1b at a location right below the pressurization plate 27 is disposed in. The container ring 60 is disposed corresponding to two edges being diagonal locations of the upper substrate 1b, and is supported by a shaft 59 extending from the upper chamber unit 21 to the bottom thereof.

[0033]

In particular, though not shown in the drawing, the shaft 59 is inserted into a through hole formed on the upper chamber unit 21. The shaft is constructed to rotate around the shaft 59 about its axial center and to move up and down. In this case, the shaft 59 is surrounded with a vacuum seal in order to prevent vacuum leakage from occurring in the decompression chamber. The rotation is performed by a rotary actuator (not shown) coupled to the end of the shaft 59, and the up and down motion is carried out by an elevation actuator (not shown) coupled to the end of the shaft 59 in the same manner. As such, as the shaft 59 is rotated and moved up and down, the substrates 1a and 1b are adhered. The container ring 60 can be removed so that the liquid crystal agent dropped on the lower substrate 1b does not interfere the diffusion of the principle surface of the substrates 1a and 1b when the liquid crystal agent diffuses.

[0034]

The construction of the XYθ stage T1 will be then described. The XYθ stage T1 includes a X stage 4a disposed on the mounting plate 2, a Y stage 4b disposed on the X stage 4a, a θ stage 4c disposed on the Y stage 4b, a table 9 which is disposed on the θ stage 4c and supports the lower substrate 1a thereon, and a lower chamber unit 10 that is fixed to the Y stage 4b through a plate 13 and has an upper side which forms the decompression chamber together with the upper chamber unit 21 perforated.

[0035]

The X stage 4a according to the present embodiment is constructed to move the Y stage 4b, the θ stage 4c, the table 9 and the lower chamber unit 10 in the left and right direction (the X-axis direction in Fig. 1), i.e., in a reciprocal motion at the bottom of the liquid crystal drop unit S1 and the substrate junction unit S2 by means of the driving motor 5. Furthermore, the Y stage 4b is constructed to move the θ stage 4c, the table 9 and the lower chamber unit 10 in the forward and backward direction (the Y-axis direction in Fig. 1) by means of the driving motor 6. More particularly, the θ stage 4c is constructed to rotate in the θ direction shown in Fig. 1 against the Y stage 4b by means of the diving motor 8 through a rotary bearing 7. In this case, the θ stage 4c is disposed to rotate against the lower chamber unit 10 through the rotary bearing 11 and the vacuum seal 12. Thus, although the θ stage 4c rotates, the lower chamber unit 10 is not moved.

[0036]

In this case, the lower substrate 1a is disposed in the gravity direction on the table 9. Thus, in order to contrive positional decision of the lower substrate 1a, the table 9 includes a positional decision device including a plurality of positional decision members 81 disposed corresponding to neighboring two circumferences of the lower substrate 1a, and a plurality of compression rollers 82 disposed corresponding to the remaining two circumferences of the lower substrate 1a, as shown in Fig. 2. The compression rollers 82 are adapted to move on the table 9 in an arrow direction shown in Fig. 2. It compress the lower substrate 1a to the positional decision members 81 using the compression rollers 82, thereby performing positional decision in a horizontal direction (a surface direction of the table 9) of the lower substrate 1a and performing the support on the table 9.

[0037]

At the time of fine positional decision right before the substrates 1a and 1b are adhered together, however, there is a possibility that the lower substrate 1a can be deviated or rises high since the upper substrate 1b is in contact with the sealant or the liquid crystal agent on the lower substrate 1a. Further, when the decompression chamber is decompressed, the air between the lower substrate 1a and the table 9 can exist during the decompression process. This may cause the lower substrate 1a to deviate. For this reason, a suction adsorption device and an electrostatic adsorption device that are constructed in the same manner as the aforementioned pressurization plate 27 are provided in the table 9. Thereby, the lower substrate 1a can be closely adhered on the table 9.

[0038]

In this case, a plurality of pins (not shown), which is projected from a mounting surface of the lower substrate 1a and can move in the up and down direction, is disposed in the table 9. The table 9 raises the pins and pushes up the substrates after adhesion. This facilitates extraction from the table 9. Further, for example, when each of the pins is raised, it is contact with the table 9 and becomes a ground state. It is thus possible to remove electricity of the substrates after adhesion.

[0039]

In the lower chamber unit 10 are provided an O-ring 44 disposed at an upper side (the circumference of the aperture) and a ball bearing 87 disposed outside the O-ring 44. As such, since the O ring 44 is provided, when the upper chamber unit 21 is lowered to make the flange 21a in contact with the O ring 44, the chamber units 10 and 21 are integrated and thus serve as a decompression chamber, as will be described later. Further, the ball bearing 87 can be set to a predetermined location of the up and down direction in order to control the compression amount of the O ring 44 when the decompression chamber is decompressed. As such, by properly adjusting the location of the ball bearing 87, force applied by decompression can be applied to the lower chamber unit 10 via the ball bearing 87. Further, since the ball bearing 87 is disposed, elastic deformation of the O-ring 44 is made possible. Thus, upon adhesion to be described later, the XYθ stage T1 can be easily moved within the elastic range of the O ring 44, so that positional decision can be performed accuracy.

[0040]

The operation of the assembly apparatus of the liquid crystal substrate according to the present embodiment will now be described.

[0041]

After a tool (not shown) that supports the upper substrate 1b is first laid in the table 9 using the hand of the moving machine, the driving motor 5 is driven to move the X stage 4a, thus moving the XYθ stage T1 below the substrate junction unit S2. Further, the motor 40 is driven to lower the pressurization plate 27. The upper substrate 1b of the table 9 is adsorbed to the pressurization plate 27. Thereafter, the motor 40 is driven to raise the pressurization plate 27, and the upper substrate 1b keeps supported by the pressurization plate 27.

[0042]

If the support of the upper substrate 1b to the pressurization plate 27 is finished, the driving motor 5 is driven to move the XYθ stage T1 below the liquid crystal drop unit S1. Further, the tool that is empty from the table 9 is released to locate the lower substrate 1a on the table 9 using the hand of the moving machine. The lower substrate 1a is positioned in the positional decision members 81 and the compression rollers 82 shown in the aforementioned Fig. 2.

[0043]

If the lower substrate 1a is supported on the table 9, the driving motors 5 and 6 are drive to move the X stage 4a and the Y stage 4b, thus discharging the sealant from the dispenser for discharging the sealant toward the lower substrate 1a while moving the XYθ stage T1 in the X-axis and Y-axis direction. At this time, the sealant is coated on the lower substrate 1a in a close pattern (for example, a □ shape). As such, after the sealant is coated, the dispenser 17 drops only a necessary amount of the liquid crystal agent within the edge consisting of the sealant. At this time, while the XYθ stage T1 is moved in the X-axis and Y-axis direction by moving the X stage 4a and the Y stage 4b, an inert gas is supplied into the cover 17k of the dispenser 17, and a desired amount of the liquid crystal agent is thus dropped on a plurality of desired locations of the lower substrate 1a.

[0044]

Though description has been omitted, a spacer is previously sprayed or attached to the upper substrate 1b or the lower substrate 1a. At this time, the spacer serves to prevent a gap between the substrates 1a and 1b from becoming over a predetermined value when the substrates 1a and 1b are adhered. Further, in a state where the spacer is mixed in the liquid crystal agent, the spacer can be sprayed together with the coating of the liquid crystal.

[0045]

As described above, after a necessary amount of the liquid crystal agent is dropped, the driving motor 5 is driven to move the XYθ stage T1 at a predetermined location below the substrate junction unit S2. Further, if the XYθ stage T1 is stopped, the cylinder 22 is driven to lower the upper chamber unit 21 and to cause the flange unit 21a to be in contact with the O ring 44. The decompression chamber consisting of the lower chamber unit 10 and the upper chamber unit 21 is thus completed.

[0046]

After the decompression chamber is formed, the vacuum valve 23 is opened to decompress the decompression chamber. At this time, since the upper substrate 1b is adsorbed to the pressurization plate 27 as described above, suction adsorption force that is being applied to the substrate 1b becomes small while the decompression chamber is decompressed. The upper substrate 1b cannot be maintained and the upper substrate 1b drops due to its weight. Due to this, the contain ring 60 shown in Fig. 2 is moved by means of the aforementioned rotary actuator or the elevation actuator. The upper substrate 1b is contained in the contain ring 60 and is then supported at a location right below the pressurization plate 27.

[0047]

When the decompression chamber is sufficiently decompressed, a voltage is applied to the electrostatic adsorption device provided in the pressurization plate 27. The upper substrate 1b on the contain ring 60 is supported in the pressurization plate 27. At this time, since the decompression chamber is significantly decompressed and the air does not exist between the pressurization plate 27 and the upper substrate 1b, discharge by static electricity is not generated. Furthermore, a phenomenon that the upper substrate 1b rises high, which occurs when the air exists, is not generated.

[0048]

If the upper substrate 1b is electro-statically adsorbed, the shaft 59 is lowered by the elevation actuator and is then rotated by the rotary actuator, so that the contain ring 60 is evacuated not to hinder adhesion of the substrates 1a and 1b. Further, the motor 40 is driven to lower the pressurization plate 27, and the upper substrate 1b is made approach the lower substrate 1a. Thereafter, the positional matching marks provided in the substrates 1a and 1b are read using the image recognition camera, and positional deviation is measured through an image process. The operation of the X stage 4a, the Y stage 4b and the θ stage 4c is controlled based on the measurement, and the table 9 is moved. Thus, the lower substrate 1a and the upper substrate 1b can be positioned with high accuracy. In this case, since the ball bearing 87 as described above is provided in the lower chamber unit 10, the ball bearing 87 can maintain the distance between the chamber units 10 and 21 as the table 9 is moved. It is also possible to maintain the vacuum state (a decompression state) without significantly changing the O-ring 44.

[0049]

If the positioning is finished, the pressurization plate 27 is further lowered and the bottom of the upper substrate 1b becomes in contact with the sealant on the lower substrate 1a. At this time, while the load meter 33 measures pressurization applied to the sealant, the driving force of the motor 40 is controlled to adhere the substrates 1a and 1b at a predetermined distance. In this case, since the upper substrate 1b is adhered to the pressurization plate 27 by means of electrostatic adsorption force, the center of the upper substrate 1b does no sink. Accordingly, it does not have a bad influence on the spacer in the liquid crystal agent, or defective positioning among the substrates 1a and 1b does not occur.

[0050]

In this case, if the area of the adhered substrates increases, the sealant cannot be sufficiently adhered only with adhesion by the aforementioned pressurization force. Due to this, if adhesion (preliminary pressurization) by pressurization force is completed, electrostatic adsorption of the pressurization plate 27 is released and the cylinder 22 is driven to raise the upper chamber unit 21. The vacuum valve 23 is then closed and the gas purge valve 25 is opened to supply nitrogen gas or clean dry air to the vacuum chamber, returning the vacuum chamber to the atmospheric pressure. As such, since the vacuum chamber returns to the atmospheric pressure, pressure is applied to the liquid crystal substrates, so that the substrates can be surely adhered to a desired thickness (main pressurization).

[0051]

At this time, when the pressure within the vacuum chamber changes from the vacuum state to the atmospheric pressure, high pressure is uniformly applied to the substrates 1a and 1b from the outside since a space portion between liquid crystal agents between the substrates 1a and 1b is in the vacuum state. For example, if the atmospheric pressure is applied when the space portion between the substrates 1a and 1b is in the vacuum state, power of 121.6 kN can be applied. The main pressurization performs adhesion using the pressure applied to each of the substrates 1a and 1b.

[0052]

If the adhesion is completed, the gas purge valve 25 is closed and the XYθ stage T1 returns below the liquid crystal drop unit S1. The adhered substrates are taken out from the table 9 using the hand of the moving machine. Adhesion of next substrates is then prepared. The substrates that are taken out after the adhesion are sent to an UV light radiation device or a heating device in order to harden the sealant.

[0053]

As described above, in the present embodiment, the sealant is coated and the liquid crystal agent is dropped in the inert gas atmosphere or under the vacuum atmosphere. That is, since the liquid crystal agent can proceed to the adhesion process, dust is not easily attached to the substrates before adhesion. Further, due to this, defective parts are not easily generated in the substrates after the adhesion due to dropped marks as in the prior art. The yield can be also improved. In addition, with the lower substrate 1a being kept, the XYθ stage T1 is moved and the lower substrate 1a is pressurized against the upper substrate 1b, so that the liquid crystal agent is diffused over the entire substrates. It is thus possible to reduce the supply of the liquid crystal agent to the lower substrate 1a and also to narrow the gap in the amount of supply. That is, since the expansion of the liquid crystal agent is performed among adhered substrates, a liquid crystal agent supply process to an adhesion process can be performed within a short time, and the productivity can be improved accordingly.

[0054]

Furthermore, the gap in the supply amount of a liquid crystal agent is narrowed. That is, since an exact amount of the liquid crystal agent can be supplied by supplying an inert gas from the dispenser 17, waste of the liquid crystal agent can be obviated. Further, there is no possibility that substrates can be contaminated since the liquid crystal agent overflows the outside of a pattern of the sealant. In this case, since a cleaning process of contaminated substrates becomes unnecessary, the productivity can be further improved.

[0055]

Furthermore, the XYθ stage T1 that supports the lower substrate

1a thereon can be used to return the upper chamber unit 21 of the upper substrate 1b. It is thus possible to miniaturize an assembly apparatus even without using other equipment for returning the upper substrate 1b.

[0056]

Furthermore, the present invention is not limited to the above embodiment, but can be implement as follows.

(1) The liquid crystal agent dropped on the lower substrate 1b can have a linear shape as well as a dot shape as in the present embodiment.

(2) A relative motion direction among substrates, which expands a liquid crystal agent, can be a circular shape or a spiral shape if the liquid crystal agent does not overflow a pattern of a sealant.

(3) The upper substrate 1b is not mounted in the XYθ stage T1, but can be directly returned from the hand of the moving machine to the pressurization plate 27 in order to be mounted in the XYθ stage T1 in the present embodiment.

(4) In the present embodiment, it has been illustrated that the circumference of the dispenser 17 is surrounded with the cover 17k and locally supplies an inert gas. However, the whole assembly apparatus can be disposed within a chamber of the inert gas atmosphere or a decompression chamber, so that the drop atmosphere of the liquid crystal agent becomes an inert gas or vacuum (decompression) state.

(5) In the present embodiment, it has been illustrated that a sealant is coated on the lower substrate 1a. However, the sealant can be coated on the upper substrate 1b. In this case, however, after the sealant is coated on the upper substrate 1b, a process of reversing the upper

substrate 1b is necessary. It is thus preferred to properly select which substrate will be coated with a sealant.

[0057]

An assembly apparatus of a liquid crystal substrate according to a second embodiment of the present invention will now be described. In this case, the same reference numerals as those of the aforementioned first embodiment will be used to identify the same construction as that of the first embodiment.

[0058]

The present embodiment and the first embodiment are different from each other in that in the first embodiment, the drop of a liquid crystal agent is performed in an inert gas or under a vacuum atmosphere, whereas in the present embodiment, the liquid crystal agent is sprayed in order to further reduce a dropped mark on a liquid crystal drop plane of the lower substrate 1a. Further, the dropped mark does not have influence on the display of a liquid crystal panel. Moreover, in the first embodiment, the liquid crystal agent is diffused in adhering substrates. In the present embodiment, however, the liquid crystal agent is diffused before the adhesion. Thus, the viscosity is different.

[0059]

The construction of the assembly apparatus according to the present embodiment is the same as that of the first embodiment except that the dispenser 47 shown in Fig. 4 is used instead of the dispenser 17 according to the first embodiment, and the liquid crystal agent or the inert gas is sprayed from the two-fluid nozzle 47a to be described later (e.g., two-fluid nozzle BIMV4502 by Kirinoikeuchi Co., Ltd.). For example, in the present embodiment, particles are sprayed about 10 μm.

[0060]

The dispenser 47 includes a syringe 47e that contains a liquid crystal agent, a first pressure controller 47b that controls the pressure of a transferred inert gas as will be described later, a pipe $47h_1$ that introduce the inert gas output from the first pressure controller 47b into the syringe 47e, and a first electronic valve 47d that operates according to a signal from the controller 47i, in the same manner as the dispenser 17 of the first embodiment.

[0061]

Furthermore, the dispenser 47 includes a connection member 47f that communicates with the inside of the syringe 47e disposed in the front end portion of the syringe 47e, a manifold 47g that communicates with the inside of the syringe 47e through the connection member 47f, a second pressure controller 47m that controls the flux of an inert gas as will be described later, a pipe 47hl that supplies the inert gas received from the second pressure controller 47m to the manifold 47g through a second electronic valve 47n that operates according to a signal from the controller 47i, and a two-fluid nozzle 47a that discharges a liquid crystal agent and an inert gas supplied to the manifold 47g. In this case, the first electronic valve 47d and the second electronic valve 47n can be independently controlled by the controller 47i.

[0062]

At this time, to the dispenser 47 is connected a pressure source such as a pump (not shown) and an air filter in the same manner as the dispenser 17 of the first embodiment. The inert gas transmitted from the pressure source passes through the air filter, and an inert gas that does not contains impurities such as waste is transmitted. The transmitted inert gas is pressurized and controlled to a predetermined pressure (0.1 MPa in the present embodiment) by means of the second pressure controller 47m, and is thus supplied to the manifold 47g by driving the second electronic valve 47n. Furthermore, the transferred inert gas is pressurized and controlled to a predetermined pressure (0.3 MPa in the present embodiment) by means of the first pressure controller 47b, and the predetermined pressure is applied to the syringe 47e by means of the inert gas.

[0063]

The discharge of the liquid crystal agent is performed in a plunger mode. To be more precise, only while the first electronic valve 47d operates, a needle (not shown) within the syringe 47e is opened, and at the same time, the liquid crystal agent is forced sent to the manifold 47g by means of the pressure of the inert gas, which is applied to the syringe 17e. Further, a liquid crystal agent 47j that is made foggy by the two-fluid nozzle 47a is sprayed to a fixed quantity.

[0064]

The operation of the assembly apparatus according to the present embodiment will be below described.

[0065]

In this case, a process until the liquid crystal agent is supplied to the lower substrate 1a in the present embodiment and an adhesion process after the supply process are the same as those of the first embodiment. Thus, only the process of supplying the liquid crystal agent will be described.

[0066]

When supplying the liquid crystal agent to the lower substrate 1a, the second electronic valve 47n is first driven, and an inert gas, which is pressurized and controlled to 0.1MPa using the second pressure controller 47m, is then supplied to the manifold 47g. Further, only an inert gas is sprayed from the two-fluid nozzle 47a, and the circumference of the lower substrate 1a laid on the table 9 is kept in the inert gas atmosphere in advance. Thereafter, the first electronic valve 47d is driven to supply the liquid crystal agent 47j to the manifold 47g. At this time, the liquid crystal agent 44j can be sprayed and supplied on the lower substrate 1a by a predetermined quantity without moisture in the air or impurities being mixed therein.

[0067]

The first electronic valve 47d is shut to stop the supply of the liquid crystal agent. At this time, the second electronic valve 47n continues to operate, so that the inert gas can be continually sprayed. Thereby, since the liquid crystal agent sprayed on the lower substrate 1a is diffused by the inert gas, a dropped mark is not generated on the lower substrate 1a. As such, after the liquid crystal agent is sufficiently spread on the inner side of the pattern of the sealant, substrates are adhered in the same manner as the first embodiment.

[0068]

As described above, in the present embodiment, after a sealant is coated, the circumference of the lower substrate 1a is kept in the inert gas atmosphere. The liquid crystal agent is sprayed to the lower substrate 1a during the inert gas atmosphere, i.e., proceeding to an adhesion process. Thus, dust is rarely attached to substrates before adhesion. Due to this, defective parts are not easily generated in the substrates after the adhesion due to dropped marks as in the aforementioned prior art, and the yield upon production can be improved accordingly. Furthermore, as a liquid crystal agent is sprayed, the liquid crystal agent is previously sprayed over the entire substrate plane before an adhesion process. It is thus possible to reduce the supply part of the liquid crystal agent to the lower substrate 1a, and also to narrow the gap in the amount of supply. Accordingly, since the process can shift from a liquid crystal agent supply process to an adhesion process within a short time, the productivity can be improved.

[0069]

Furthermore, the gap in the supply amount of the liquid crystal agent can be narrowed. That is, an exact amount of the liquid crystal agent can be supplied from the dispenser 47. Waste of the liquid crystal agent can be obviated. Further, there is no possibility that the liquid crystal agent can overflow into a pattern of a sealant and contaminate substrates. In this case, since a cleaning process of contaminated substrates is unnecessary, the productivity can be further improved.

[0070]

Furthermore, the XYθ stage T1 that supports the lower substrate 1a thereon can be used to return the upper substrate 1b to the upper chamber unit 21. It is possible to miniaturize an assembly apparatus even without using other equipment for returning the upper substrate 1b.

[0071]

Furthermore, the present invention is necessarily not limited to the above embodiments, but can be implemented as follows.

[0072]

(1) The two-fluid nozzle 47a that sprays a liquid crystal agent can be adequately changed depending upon the particle diameter of spray, the range of spray, the viscosity of a liquid crystal agent and the like.

(2) The dispenser 47 of the plunge mode, which supplies a liquid crystal agent in the fixed quantity, can have other types if they can supply the liquid crystal agent in the fixed quantity.

(3) The pressure controlled by the first and second pressure controllers 17b and 17m can be adequately adjusted depending upon the particle diameter of spray, the range of spray, the viscosity of a liquid crystal agent and the like.

(4) While a liquid crystal agent is sprayed, the lower substrate 1a is fixed on the table 9, and the XYθ stage T1 is also fixed. However, the spray range can be changed by moving the table 9 in the XY direction in this state. [0073]

Furthermore, in each of the aforementioned embodiments, it has been illustrated that a liquid crystal supply portion and an adhesion part are integrated. However, the present invention is necessarily limited thereto, but can be modified in various ways.

[0074]

[Effect of the Invention]

As described above, according to a method of assembling a liquid crystal substrate and assembly apparatus thereof, and a liquid crystal supply apparatus in accordance with the present invention, while a liquid crystal agent is supplied to substrates, moisture in the air or impurities are not mixed, and the liquid crystal agent is not oxidized. It is thus possible to prohibit generation of dropped marks of a liquid crystal agent. Accordingly, a liquid crystal panel without a display stain can be produced.

[Description of Drawings]

Fig. 1 is a partial cross-sectional view showing the construction of a substrate adhesion apparatus according to a first embodiment of the present invention.

Fig. 2 is a perspective view illustrating a contain ring of an upper substrate or a positional decision device of a lower substrate according to the present embodiment.

Fig. 3 is an explanatory view showing the construction of a dispenser that supplies a liquid crystal agent according to the present embodiment.

Fig. 4 is an explanatory view showing the construction of a dispenser used in a substrate adhesion apparatus according to a second embodiment of the present invention.

[Description of Numerals]

1a, 1b: Substrate

9: Table

17: Dispenser (liquid crystal supply device, liquid crystal supply apparatus)

17e: Syringe

17k: Cover

17m: Flow controller (Inert gas supply unit)

17n: Electronic valve (Inert gas supply unit)

27: Pressurization plate

47: Dispenser (liquid crystal supply device, liquid crystal supply apparatus)

47a: Two-fluid nozzle

47e: Syringe

47g: Manifold

47m: Second pressure controller (Inert gas supply unit)

47n: Second electronic valve (Inert gas supply unit)